QUALITY ASSURANCE PROJECT PLAN
for
GLANSIS: SCIENCE AND MANAGEMENT SUPPORT PROJECT

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

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National Oceanic and Atmospheric Administration

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GLERL Director

GLANSIS Executive Team

GLANSIS Project Manager

USGS NAS Program Leader

MI Sea Grant Director

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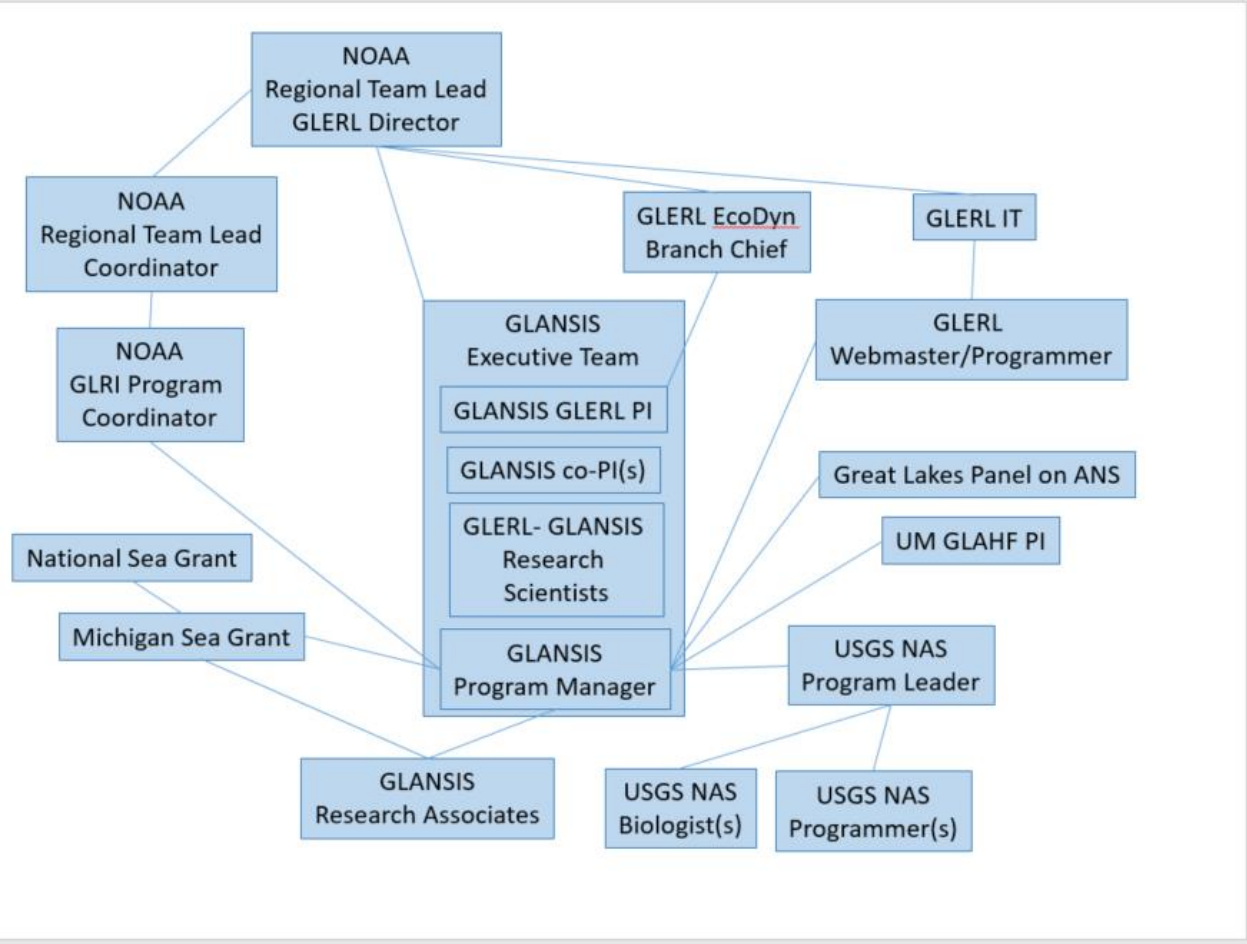

Figure 1. Organizational Chart (primary lines of reporting/communication)

NOAA Regional Team Lead/GLERL Director – Represents GLANSIS to OAR and NOAA Administration. Serves as the head of GLANSIS to the Great Lakes and Lake Champlain Invasive Species Program (GLLCISP).

GLERL EcoDyn Branch Chief – GLANSIS is a project within GLERL's Ecosystem Dynamics (EcoDyn) Branch. The Ecodyn Branch Chief is responsible for ensuring all projects within the Branch are properly incorporated into GLERL's Annual Execution Plans.

GLANSIS Executive Team Members – GLANSIS PI(s), NOAA's Representative to the Great Lakes Panel on ANS, other NOAA-GLERL researchers with an interest in AIS, and the GLANSIS Program Manager who provide overall leadership to GLANSIS. Responsibilities:

1) Provides general direction for GLANSIS

2) Serve as expert reviewers as appropriate

3) Provide feedback on revisions and upgrades to the GLANSIS website

4) Assist with development of and/or provide feedback on proposals

NOAA PIs – Responsibilities:

1) Serve on the Executive Team (additional responsibilities above)

2) Develop and ensure implementation of QA/QC protocols.

3) Provide fiscal oversight of the project.

4) Provide technical oversight of the project.

5) Develop new proposals.

6) Oversee all formal communications up the NOAA chain of command (i.e., AEP).

GLANSIS Program Manager – Responsibilities:

1) Oversees daily operation of the database.

2) Ensures all elements of GLANSIS are performed as required and milestones are met.

3) Drafts all program reports (with review by Executive Committee).

4) Designates/prioritizes daily tasks to GLANSIS Programmer and Research Associates.

5) Works with the GLANSIS Executive Team and the USGS NAS Program Leader to update or plan and implement new database information products.

6) Conducts QA/QC on all data entry, profiles, listings, and publications.

7) Plans and implements outreach activities, such as website content, photos (including copyright permissions), presentations, and interactions with user communities (including reports, monitoring, and alerts).

8) Provides reports/analyses to other agencies as requested (e.g., State of the Great Lakes Indicator Report)

9) Engages with regional and national partners as needed for specific sub-projects.

10) Fills gaps in daily operations including data analysis, research, writing profiles, answering public queries, outreach, and writing journal articles.

Research Associates – Responsibilities:

1) Review of relevant scientific literature as assigned.

2) Organize gathered data within species-specific templates for assessment.

3) Develop/update species-specific profiles.

4) Submit changes to profiles for review by GLANSIS Program Manager and Expert Reviewers.

5) Data entry and analysis.

6) Beta testing database interface programming changes

7) Write/edit manuscripts, outreach materials, etc.

8) QA/QC of assigned work (e.g., associates may be tasked to review work of another associate to help improve consistency and quality).

NOAA GLRI Program Coordinator – Responsibilities:

1) Reviews project quality documentation.

2) Ensures NOAA and GLRI project quality standards are met.

MI Sea Grant Director/Extension Program Leader – Responsibilities:

1) Manages sub-award to MISG (for GLANSIS staff support and other partnership activities).

2) Ensures reporting on sub-award activities.

UM GLAHF PI

1) Serves as the primary point of contact for the UM GLAHF database.

2) Oversees the core UM GLAHF database management and maintenance.

3) Works with the GLANSIS Executive Team and Program Manager to update or plan and implement new GLANSIS database information products that interface with UM GLAHF, including development of proposals for new products that require UM GLAHF support.

4) Where needed (e.g., shared data fields, programming changes across the GLANSIS- UM GLAHF interface or to UM GLAHF that affect GLANSIS) assigns UM GLAHF Programmers and/or Biologists to work directly with GLANSIS staff.

5) Provides initial (structure) and final (review) quality control checkpoint to core GLANSIS data and products (those residing on UM GLAHF servers).

GLERL Webmaster/Programmer

1) Oversees/Implements all changes to programming structures that reside on GLERL servers.

2) Ensure compliance with all NOAA web standards.

USGS Nonindigenous Aquatic Species (NAS) Database Program Leader – Responsibilities:

1) Serves as the primary point of contact for NAS.

2) Oversees the core NAS database management and maintenance.

3) Works with the GLANSIS Executive Team and Program Manager to update or plan and implement new GLANSIS database information products that interface with USGS NAS, including development of proposals for new products that require NAS support.

4) Where needed (e.g., shared data fields, programming changes across the GLANSIS-NAS interface or to NAS that affect GLANSIS) assigns NAS Programmers and/or Biologists to work directly with GLANSIS staff.

5) Provides initial (structure) and final (review) quality control checkpoint to core GLANSIS data and products (those residing on USGS servers).

USGS Nonindigenous Aquatic Species (NAS) Programmer – Responsibilities:

1) Ensures technical operation of the NAS database.

2) Works with the GLANSIS Programmer to update or develop and implement new GLANSIS database interface program code.

Great Lakes Aquatic Nuisance Species Panel Members– Responsibilities:

1) Provide general advice to key GLANSIS staff on the value of current and potential GLANSIS database information products to ensure that GLANSIS is responsive to regional invasive species informational needs.

External Reviewers (Volunteers) – Responsibilities:

1) Provide technical review of GLANSIS database species data products (e.g., listing criteria, species templates, prioritizations, etc.).

A5. Problem Definition/Background

The Great Lakes have been heavily impacted by aquatic nonindigenous species (ANS) since the 1800s, and now more than 180 ANS are established here. A huge wealth of data is distributed among journals, grey literature, electronic literature sources, and on-line databases, making it unmanageable for any individual. NOAA and USGS launched the Great Lakes Nonindigenous Aquatic Species Information

System (GLANSIS) to provide a comprehensive, quality controlled, easily accessible on-line database of Great Lakes ANS. Among the goals of GLANSIS are to 1) provide a comprehensive source of authoritative up-to-date Great Lakes ANS information and 2) to meet the ANS information needs of regional stakeholders, managers and scientists.

Goals/Objectives

The purpose of this work is to enhance and improve information for aquatic invaders in the Great Lakes available through GLANSIS.

GLANSIS is fully integrated with the USGS-NAS database (http://nas3.er.usgs.gov/). GLANSIS presently contains records and information for >290 aquatic species that have invaded the Great Lakes or threaten to do so. Activities supported by this project will help enhance the database by allowing GLANSIS to:

1) Screen and revise GLANSIS species profiles to improve quality, consistency, and accurately reflect current state of scientific knowledge.
2) Update the GLANSIS database as needed to include new species that meet GLANSIS criteria for inclusion.
3) Expand GLANSIS to include new tools and information to meet the needs of Great Lakes scientists, managers and stakeholders in support of prevention, early detection, rapid response, and control.

GLANSIS Definitions and Criteria for Listing (approved by Expert Review Panel 2008 with revisions by the GLANSIS Executive Committee 2020)

GLANSIS is phasing in a new controlled vocabulary for stages of establishment. This new vocabulary is consistent with the terms used by USGS NAS, except insofar as NAS frames to the US boundaries and GLANSIS frames to the Great Lakes basin. The vocabulary is derived from Darwin core, except for the term invasive, for which we retain the US legal definition (a non-native species that causes environmental or socio-economic harm). The term establishment is used to refer to the overall process from initial introduction to complete filling of all available suitable niches. Discrete stages within the establishment process are called out falling the terms highlighted in green in Figure 2.

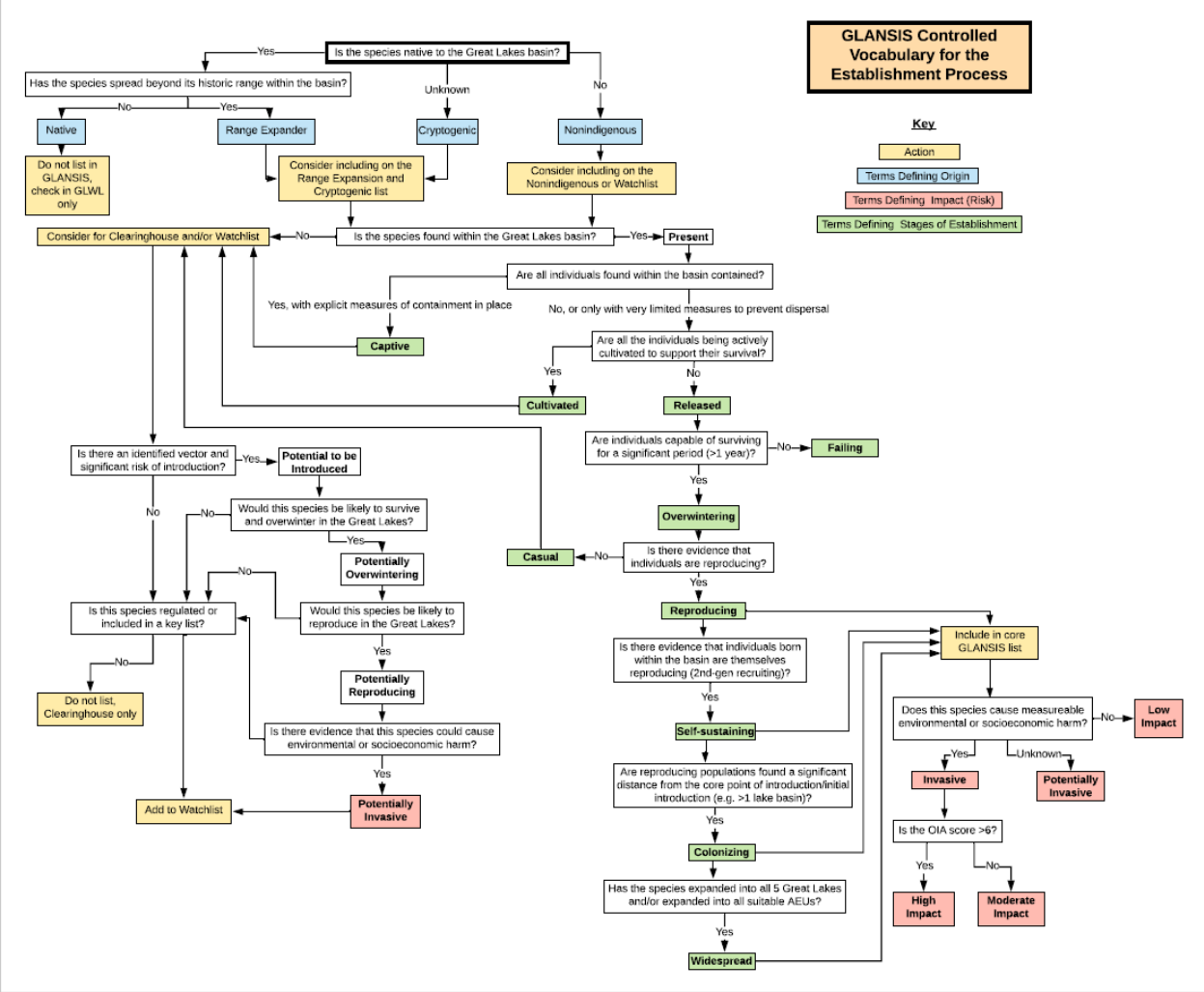

Figure 2: Controlled vocabulary for the establishment process including delineation of the GLANSIS listing criteria for Nonindigenous, Range Expansion, and Watchlist.

GLANSIS Definitions and Criteria for Listing as Nonindigenous (approved by Expert Review Panel 2008 with revisions by the GLANSIS Executive Committee 2020)

Geographic criterion: Only species which are present in the Great Lakes basin below the ordinary high water mark—including connecting channels, wetlands and waters ordinarily attached to the Lakes—are included in the core GLANSIS nonindigenous species list. Species which have invaded inland lakes within the Great Lakes basin but not meeting the above geographic criterion are not included in the nonindigenous species list category, but may be included in the Watchlist (see below).

Aquatic criterion: GLANSIS includes only aquatic species. USDA wetland indicator status is used as a guideline for determining whether wetland plants should be included in the list—OBL, FACW, and FAC wetland plants are included in this list as aquatic; FACU and UPL plants are not. Waterfowl, amphibians, reptiles, and mammals spending significant time in and dependent on the water are not currently included, but are being considered for addition to the database.

Nonindigenous criterion: The species included in GLANSIS are those that are considered nonindigenous within the Great Lakes basin according to the following definitions and criteria (based on Ricciardi 2006):

- appeared suddenly and had not been recorded in the basin previously;
- subsequently spreads within the basin;
- its distribution in the basin is restricted compared to native species;
- its global distribution is anomalously disjunct (i.e. contains widely scattered and isolated populations);
- its global distribution is associated with human vectors of dispersal;
- the basin is isolated from regions possessing the most genetically and morphologically similar species.

Cryptogenic species are those species that cannot be verified as either native or introduced (after Carlton, 1996). These include species that may have been identified as invasive by one researcher, but for which a literature review reveals conflicting opinions. For example, *Paranais frici* and *Pritina acuminata*, listed as invasive by Trebitz et al. 2009, are not considered so by others (Moroz 1994, Spencer & Hudson 2003). Species that have been identified as cryptogenic are not listed as nonindigenous (but see below).

Reproducing and Overwintering criterion: A nonindigenous species is considered for listing on the core nonindigenous list if it has a reproducing population within the basin, as inferred from multiple discoveries of adult and juvenile life stages over at least two consecutive years. Species are excluded from the core list (but may be included on the watchlist) if their records of discoveries are based on only one or a few non-reproducing individuals whose occurrence may reflect merely transient species or unsuccessful invasions.

Criteria for Range Expansion and Cryptogenic Species List (approved by Expert Review Panel 2010)

Geographic Criterion: Species are regarded as 'native' or 'possibly native' to a portion of the Great Lakes basin, as specified within the above GLANSIS criteria, when historically recorded and reproducing in a localized region of the basin (below ordinary high watermark, including connecting channels, etc.).

Aquatic criterion: GLANSIS includes only aquatic species. USDA wetland indicator status is used as a guideline for determining whether wetland plants should be included in the list—OBL, FACW, and FAC wetland plants are included in this list as aquatic; FACU and UPL plants are not. Waterfowl, amphibians, reptiles, and mammals spending significant time in and dependent on the water are not currently included. [same as above]

Range Expansion criterion: The species included in GLANSIS are those which are considered to be expanding their range within the Great Lakes basin according to the following definitions and criteria:

- appear suddenly in parts of the basin historically not documented;
- subsequently spread within the basin beyond historically recorded region of establishment;
- have an anomalous distribution associated with human vectors of dispersal;
- are genetically and morphologically similar to the formerly localized, 'native' population;
- are cryptogenic to only a portion of the Great Lakes basin and are clearly spreading beyond their historically documented distribution.

Criteria for Watchlist Species (approved by Expert Review Panel 2010, with minor revisions approved by the GLANSIS Executive Committee in 2020)

Geographic criterion: Lives in a known donor region (e.g., rivers adjacent to Great Lakes, inland lakes in the Great Lakes region, western Europe, the Ponto-Caspian region) or in a zone with high specialization, species pool, or climate conditions that match the Great Lakes.

Aquatic criterion: Within the context of the Great Lakes Aquatic Nonindigenous Species Information System (GLANSIS), the criterion of including only aquatic species is unchanged. USDA wetland indicator status is used as a guideline for determining whether wetland plants should be included in the list—OBL, FACW, and FAC wetland plants are included in this list as aquatic; FACU and UPL plants are not. Waterfowl, amphibians, reptiles, and mammals spending significant time in and dependent on the water are not currently included but are being considered for addition to the database.

Established (Reproduction) criterion: NOT already reproducing and/or overwintering in the Great Lakes, but assessed as 'likely' to successfully do so in the Great Lakes based on peer-reviewed scientific literature or other federal/state agency risk assessment literature.

Watchlist-specific criteria: (must meet at least 3)

- A transport vector currently exists that could move the species into the Great Lakes AND
- The species is likely to tolerate/survive transport (including in resting stages) in the identified vector AND
- The species has a probability of being introduced multiple times or in large numbers AND
- The species is likely to be able to successfully reproduce and overwinter in the Great Lakes (based on known tolerances or climate matching). AND
- The species has been known to impact other areas OR is assessed as likely to impact the Great Lakes system.

OR

- The species has been officially listed as a potential invasive species of concern by federal, state or provincial authorities with jurisdiction in the Great Lakes basin.

A6. Project/Task Description

1) Maintenance and expansion of the Risk Assessment Clearinghouse: Published and gray literature, including risk assessment results and model outputs, is reviewed by the Program Manager and Research Associates to assess the relative risk of nonindigenous species to the Great Lakes and for determination of appropriate response strategies. The Clearinghouse includes summaries of priority assessments (methodologies identified by the Great Lakes Panel on ANS Ad Hoc Risk Assessment Committee as in current use by managers in the Great Lakes basin). GLANSIS Risk Assessment (GLANSRA) is conducted using the protocol of Davidson et al 2016 (details in NOAA TM-169) which was developed specifically for GLANSIS. A parallel protocol (TM-161) is applied to consistently evaluate

the impact of reproducing nonindigenous and range expansion species (Organism Impact Assessment - OIA). A conservative application of the precautionary principle will ensure that both impacts and the current state of knowledge are not overstated. All assessments are reviewed by the Program Manager and at least one additional member of the Executive Committee. Comments from external reviewers with particular relevant expertise are solicited. All Risk Assessments and Organism Impact Assessments are summarized in the Clearinghouse as well as published annually as NOAA Technical Memoranda (TM-161 and TM-169 sequences). The GLANSIS RA Clearinghouse leverages the NAS reference database which resides on USGS servers, but otherwise its data tables and information reside on NOAA servers and will be maintained by GLANSIS staff.

2) Population of the Impact Database: In parallel with the Clearinghouse, USGS NAS has developed a database to store the core impact statements. All statements used in the GLANSRAs and OIAs (both new and pre-existing) will be individually tied to the original references and parsed into this new database structure.
3) Maintenance and update of core database lists: Nonindigenous, Range Expansion and Cryptogenic, and Watchlist. – Any species listed by a governmental agency or legislation with jurisdiction in the Great Lakes basin is automatically considered for GLANSIS listing. Published literature reviews and expert solicitation is used by the Program Manager and Research Associates to identify additional species meeting the criteria for listing. Candidates for listing are screened (e.g., eliminating tropical species) and assessed (#1 above). All changes to the candidate or final lists are communicated to the members of the Great Lakes Panel on ANS at their semi-annual meetings.
4) Species Profile Updates: A thorough literature review is conducted for each listed species at least every 5th year. Bibliographies, profile information and maps are updated based on this review. All updates are reviewed by the Research Associate(s), GLANSIS Program Manager, and at least one additional member of the Executive Committee prior to posting. External review is solicited where particular additional expertise is needed. Reviewers are also solicited from the membership of the Great Lakes Panel on ANS. All map data, references, and information in shared fields (e.g., Ecology) is also reviewed by USGS NAS Biologists. The Great Lakes Panel on ANS is apprised of all substantial updates.
5) Outreach – The Program Manager and Research Associates develop, as needed, outreach materials based on existing GLANSIS species profiles and other information contained within the database. These materials include flyers, posters, maps, etc. Other outreach products include extension articles, scientific reports and presentations at scientific meetings. NOAA-GLERL Information Services and EcoDyn Branches and all relevant partners are kept apprised of outreach products and presentations and NOAA clearance is obtained where necessary. All outreach products include NOAA and GLRI logos or credit line and additional partners are clearly credited where relevant.
6) Map Explorer – The GLANSIS Map Explorer interface was developed in partnership with USGS NAS and the University of Michigan Great Lakes Aquatic Habitat Framework. Core species distribution data resides on the USGS servers and is accessed by GLANSIS via API. All other GIS layers, including the habitat suitability maps, reside on UM servers and are maintained by GLAHF. The processing interface resides on NOAA servers and is maintained by GLERL. Habitat suitability maps included in the Map Explorer were (and will in the future be) selected by the GLANSIS Executive Committee.
7) Database Technical Operations – The GLANSIS Program Manager and Programmer work with the USGS NAS Program Leader and Programmer to maintain the GLANSIS database

architecture, ensure continuous technical operations, and when needed, develop and implement new interface program code to accommodate new informational data products.

Table 1. Time Schedule and Milestones

Milestones and Deliverables	Anticipated completion date (by Quarter, i.e. FY17 Q4)
Species Profile Updates – all species profiles have been updated within the last 5 years. (100% complete for CY 2021)	FY21 Q1
Risk assessments associated with 2 new major methods will be added to the clearinghouse	FY20Q4
New Risk Assessments - ~100 new GLANSIS Risk Assessments completed and added to the RA Clearinghouse for species previously identified in peer-reviewed literature, legislation or by other assessors as posing a significant risk to the Great Lakes.	FY20Q3
New Species Profiles – Profiles added to the GLANSIS watchlist for species identified as posing high/moderate risk in the new RAs	FY21Q1
OIA/RA Tech Memos Published for CY21	FY21Q2
Education Needs Assessment	FY20Q4
Improve Information Access – Update GLANSIS Glossary	FY20Q2
Improve Information Access – Redesign impact information delivery (new product or section update)	FY20Q3

A7. Quality Objectives and Criteria

Literature searches are used to identify and gather information about ANS impacts, range expansion ANS, watchlist ANS, and ANS management practices. Peer-reviewed publications (including risk assessments and ecosystem model forecasts) are sought first, followed by federal and state agency reports and other online fact sheets, books, professional communications with experts around the Great Lakes basin, and news stories, respectively. Prior to posting species profiles online, these materials are reviewed by the GLANSIS Executive Team and additional external reviewers are solicited to fill gaps in expertise. The Reviewer's recommendations are then taken into consideration, sent back for subsequent review if revisions are substantial, and only published online once all changes have been accounted for. In the event reviewers feel themselves unable to review a particular species' information, we ask them to suggest alternate reviewers. Where the database overlaps with USGS NAS, NAS staff also provide a second review. Additional external review is welcome at any time and all feedback taken seriously.

Assessment frameworks are developed from consensus among expert judgment and commonalities among published studies as outlined in NOAA TM-161 and 169. Information about management policies is sourced from existing clearinghouse such as the Sea Grant Database of Aquatic Species Regulations (www.iiseagrant.org/SpeciesRegs; developed by IL-IN Sea Grant, with support of the Sea Grant Law Center), as well as individual Great Lakes state and provincial management plans, legislation, and regulations. Review of this information is solicited from members of the Great Lakes Panel on ANS.

The source of all information is provided with a full bibliographic citation, so that the user may come to his/her own conclusion about data suitability. When conflicting source information arises, we present both sides of the issue.

Further quality objectives for particular GLANSIS products are given below:

Species Lists – GLANSIS provides a master list of nonindigenous aquatic species in the Great Lakes that is frequently cited. We have added similar lists for 'range expansion and cryptogenic species' as well as watchlist species. GLANSIS users can generate custom lists on lake-specific, basin-specific, and watershed-specific bases. We aim to provide lists that are: (1) generated based on explicitly defined criteria (see Section A6); (2) vetted by experts, and therefore; (3) citable as credible information sources.

Report Data – GLANSIS aims to provide only the highest quality information suitable for research. Many of the database report fields are menu driven to ensure consistency in reporting. All records are georeferenced to 'accurate,' 'approximate,' or 'centroid' points. All reports include a date (at least to year, more specific if available) that is recorded as an estimated introduction date, actual collection date, verification date, or publication date. Available data fields are as follows (* indicates a required field):

*ITIS Number (if applicable)
*Group
*Order
*Family
*Genus
*Species
Subspecies
Variety
Common Name
Synonyms
*Authority
*Freshwater/Marine
*Continent of Origin
Fecundity
Temperature Tolerance Min
*Native/Exotic (relative to US)
*Country
*State
County
*fips
*HUC Number
*HUC Name
*Locality
*Lat/Lon
*Lat/Lon Source (e.g., GPS, map derived, etc)
*Accuracy (Accurate, Approximate, Centroid)
Protected Area
*Year

Month
Day
Collectors
Gear
Contact (all records must include either a contact or a reference or both)
*Pathway 1 (required, but unknown is an option)
Pathway 2
Pathway 3
Status
Reference 1 (all records must include either a contact or a reference or both)
Reference 2
Reference 3
Comments
*Record Type
Earliest Record
*Year Accuracy
Specimen Disposal
Museum Catalog Number
Verifier
Year Verified
Stock Source
Introduction Fresh/Marine
Number Stocked
Number Collected/Observed
Year Class
Size
Number Released
Number Preserved
Number Dead
Number of Juveniles
Number of Females
Number of Breeding Females
Number of Breeding Males
Impact

Technical Species Profiles – GLANSIS aims to provide a synthesis of the best available science-based information from peer reviewed publications, grey literature, government records, and the best professional judgment of expert scientists. We strive for consistency in format and detail to provide a tool suitable for management and decision-making. Fields include:

Scientific Name
Common Name
Synonyms and Other Names
Photo
Identification
Size
Native Range

Point Map (clickable to access specific records)
Link to the National Map
Nonindigenous Occurrences (including tabular access to first reports)
Link to browse Great Lakes Collection Records
Ecology
Means of Introduction
Status
Impact of Introduction
Management
Remarks
References Cited
Other Resources
Author
Contributing Agencies
Revision Date
Citation

Bibliographies – GLANSIS provides several levels of bibliographic information. A Literature Cited section is included with each species profile that includes peer-reviewed citations for all information included in the profile. These aim to document the quality of the information included in profile to a level suitable for use by managers and/or decision-makers. Each report included in the database is cited to a publication or personal communication. A file and/or photo documenting the species collection is attached to each personal communication. Full bibliographies of all references found for each species (used for the profile, risk assessments, maps or not cited directly) is also automatically compiled for each species. This bibliography is intended to be of the highest possible quality to support research.

Use of Grey Literature – Grey literature is used in developing the GLANSIS fact sheets only in cases where peer-reviewed information is unavailable or where the grey literature adds significantly to understanding of the subject. Most grey literature included in the database consists of government reports. In all cases, the full citation is included allowing the user to judge for themselves as to the quality of a particular piece of information.

A8. Special Training Requirements

All personnel engaged in data entry to the GLANSIS/NAS system are issued individual usernames and passwords. Each user is trained (several hours) in using the data entry system including use of pull-down menus, required data fields, and quality control checkpoints (outlined in Section B5). All data is permanently keyed to the username of the individual who entered the data.

A9. Documentation and Records

All species reports must include species ID (verified by an expert, by photograph, or appearing in a peer-reviewed publication), date (at least to year), and location (lat-long reported or determined from description and rated as accurate, approximate or centroid). All records are accompanied by a citation (peer-reviewed or agency publications) or a file /photograph (personal communications). See above (Section A7) for more detailed information on required fields.

All statements included in a species profile must be cited to an appropriate authority. Citations are included in the GLANSIS/USGS-NAS reference database and in the literature cited section of the profile itself.

All species lists are developed based on explicit criteria (given in Section A5). Criteria as well as the application of these criteria are reviewed by the Program Manager and the Executive Committee. Criteria and the basis for the criteria (citations) are documented on the GLANSIS website.

Because the GLANSIS database is piggybacked onto the national USGS database, all GLANSIS holdings and improvements become a permanent part of the primary database maintained and backed up by USGS.

Individual species assessments will be released through NOAA technical reports.

SECTION B: DATA GENERATION AND ACQUISITION

B1. Rationale for Sources of Existing Data

This project will use comprehensive literature searches as described in sections A6 and A7.

B2. Identification of Existing Data Sources

All existing data sources will be appropriately cited in assessments, species profiles, and publications.

B5. Quality Control Requirements

Following training and discussions with the GLANSIS Program Manager, Research Associates will conduct literature reviews, complete assessments, and draft species profiles. The GLANSIS Program Manager will review Research Associates' work, including spot-checking literature searches to see if Associates should go back for additional resources. An example of when this might be warranted would be if the Manager's search found references for information not yet documented by the Associate. Another case would be when information that the Associate has attributed to an assessment appears to be unclear or incomplete. At each of these points, the Associates will return to his/her data gathering to clarify or supplement initial work prior to subsequent review. The Program Manager also provides editorial review for grammar and spelling.

Once preliminarily approved by the Program Manager, written material is passed on for review by the Executive Committee and key external review solicited. Feedback from Reviewers is then incorporated until documentation meets their satisfaction, whereupon species profile information is entered online.

QA/QC on data entry is performed through the following means:

- All records entered by GLANSIS Research Associates are assigned by the GLANSIS Program Manager.
- The GLANSIS Program Manager reviews each posted profile for completeness and proper entry.
- The GLANSIS Program Manager spot-checks both bibliographic information and species reports entered by associates for accuracy as follows:

  - When a Research Associate is first beginning, each record is checked in its entirety (e.g., first 10 records).
  - Thereafter, records are checked periodically with decreasing frequency as Research Associate's work improves or upon completion of data entry task.
- If the Program Manager does the data entry, one of the Associates is asked to cross-check this work.
- When GLANSIS staff enter the database to look something up, they are asked to double check the formatting at the same time.
- When we receive a direct request that results in sending someone/a user to a particular page, the formatting of that page is again checked prior to sending the link. All data entered gets flagged for review by USGS NAS staff

Further quality control requirements for particular GLANSIS products are given below:

Criteria Development – Criteria for lists were developed in consultation with Expert Review as noted above. Should criteria need to be revised, this would be done by the GLANSIS Executive Team in consultation with the Great Lakes Panel on ANS. Final criteria (with references) are posted to the GLANSIS website (http://www.glerl.noaa.gov/res/Programs/glansis/glansis.html) as documentation of the criteria and terminology as well as for open comment.

Species Lists – Species lists available in the current peer-reviewed literature are compiled and subjected to the GLANSIS criteria and used as the basis for generating the species lists. These lists are reviewed by the Program Manager, checked against other federal agency listings, and provided to the Great Lakes Panel on ANS. Lists approved are published to the website and available for open comment. Suggestions for additions to (and/or deletions from) the lists are compiled and periodically evaluated by the Program Manager. This evaluation may include compilation of relevant documentation provided by the individual suggesting the listing/delisting and/or obtained by the project team. Suggestions and supporting documentation are forwarded to all Reviewers for final determination by the Executive Committee as to whether or not the species should be listed/delisted.

Technical Profiles – All information included in the profile is referenced to a reputable source in proper scientific format. Each profile includes a bibliography. Profiles are developed to a standard format determined by USGS and compatible with the USGS NAS database. Each profile is reviewed by the GLANSIS Program Manager and one or more members of the Executive Committee prior to approval. Profile sections are entered into database fields in the USGS NAS database. USGS separately reviews the profiles to ensure the information is compatible with the national framework. Published profiles include authorship and are citable as agency technical publications (grey literature). Updates and/or edits to the profiles are conducted on an ad hoc basis, in addition to a 5 year cycle. All updates/edits are reviewed by the GLANSIS Program Manager and USGS NAS staff. Significant updates may be sent for expert review.

Point Maps – Each species profile includes a point map detailing the native range (if within the US) and the introduced reports for the species. Maps are auto-generated from the reports database (see below). Maps are inspected by the Program Manager when the profile is first posted to ensure that they match the report data and by the data enterer for accurate plotting of intended location as additional points are added. Maps are also examined for gaps (missing data) and an effort is made to determine whether the gap is real (species not present) or represents missing data. If the latter, efforts are made to locate additional data to fill the gap (from existing reports) and/or monitoring groups are alerted to the data

need. The mapping system is periodically 'spot-checked' by the Program Manager as well as by USGS NAS staff as described above.

Georeferenced Habitat Data Layers – GLANSIS provides users the ability to conduct a map-based search for information on up to three species. The map-search capabilities include habitat information available from the Great Lakes Aquatic Habitat Framework database. The habitat information includes seven surface layers (depth, substrate, spring and summer surface temperatures, cumulative degree days, ice duration, and upwelling), two shoreline layers (classification and sinuosity), and eight basemap layers (topographic, National Geographic, oceans, gray, dark grey, imagery, shaded relief, and USA topographic). GLAHF maintains quality control for the habitat layers.

Species Reports – Species reports are drawn from a variety of sources, including published peer-reviewed literature, grey literature, other databases, and personal communications. Each report is documented to the maximum extent allowable. Minimally, each report includes a reference, file and/or photograph to document the finding. Every record is automatically coded with the username of the individual who entered the information; in the event of errors, this metadata helps to identify and review records for systematic patterns.

Reports from the public are accepted, but must be verified by an expert using at least photographic evidence. GLANSIS staff are trained on the data entry system, including minimum information requirements, pull down menus, verifications, when QA/QC should be performed, etc. The system is hardwired to pull down menus and will not accept data entry that is incomplete or fails to follow minimum format requirements. Data entry is spot-checked by the GLANSIS Program Manager and the USGS NAS staff as described above.

Alerts – Subscribers can receive email alerts when data is entered into the GLANSIS/NAS database. This system is entirely managed by USGS. The reports are generated automatically during data entry under certain conditions (e.g., first record of this species in a particular county) or can be added manually (e.g., when USGS staff consider a report to be particularly significant, even if there were previous reports at that location). Alerts are checked/approved by USGS staff prior to the email alert going out (even those which are auto-generated from the record data entry).

B9. Non-direct Measurements

GLANSIS draws all of its data (i.e. species information and reports) from external information sources, including peer-reviewed literature, government reports (grey literature), and other databases (e.g., species reports by other agencies, museum records, monitoring programs). These data transfers are often handled manually. All data drawn from these external sources is subject to the documentation and review processes outlined above. Where available, the external database developer (e.g., WI DNR) is cited as the verifier in addition to the original data source. GLANSIS relies on careful documentation of data sources to allow users to judge for themselves the validity and limitations of individual reports and information. Both peer-reviewed and grey literature will be evaluated for quality using best professional judgment and consistently incorporated into species assessments, as approved by the GLANSIS Program Manager in consultation with expert reviewers.

Analysis of literature for the identification of new range expansion species and watchlist species will be conducted according to the criteria provided above (Sections A7 and B5). Both the criteria themselves and the resulting lists will be vetted by expert reviewers. The impact assessment tools are developed or improved based on review of the standard methods employed in impact risk assessment as published in the peer-reviewed literature and government reports. Information (drawn from peer-reviewed literature) currently included in the GLANSIS profiles is periodically re-evaluated in a more rigorous fashion using the tools. Both the tools and their results (e.g., an Organism Impact Assessment, a revised impact section for the fact sheet) are reviewed by the GLANSIS Executive Committee for accuracy.

B10. Data Management

Information in the core GLANSIS database is stored in the USGS NAS servers and is fully integrated within the NAS database, that is, records are entered directly in the NAS database and then accessed through the GLANSIS website portal maintained by GLERL. All core GLANSIS elements are also subject to the USGS quality control procedures. These procedures are documented in the Nonindigenous Aquatic Species Database Metadata:

> "Data_Quality_Information:
>
> Attribute_Accuracy_Report:
>
> Review process for NAS records — The NAS reviews 4 different types of records: 1) Publications, 2) News, 3) Web, and 4) Personal Communication. Scientific Publications are accepted without review unless it is a very old publication or taxonomy has changed or the species has been re-identified. News is generally accepted for most species. However, some are followed up on with local biologists or by obtaining photos. These are generally the most difficult to identify species. Acceptance of web-based information depends on the website and author. Federal and state agency sites are generally taken as factual.
>
> Individual websites or fishing websites are followed up on, generally to obtain photos.
>
> For personal communications and reports submitted online, the reporter and the species are considered. Agency personnel or biologists are usually taken at their word – except for commonly misidentified species. People reporting common species known to be in the area reported are generally accepted. Anyone reporting a species significant to a new area is investigated. Our online reporting form allows for photo uploads, therefore, we ask for photos or specimens if they are available to verify the identification. After the data are entered, they are reviewed by a second person in the NAS Program. After all data are entered, the documentation (e.g., literature, e-mail exchanges, and photos) to substantiate it are attached in the form of a PDF. Users are constantly reviewing the data and alert the NAS database contact person if they find a problem."

Additionally, NAS provides the following Data Disclaimer:

> "Conclusions drawn from the information portrayed in this website are the sole responsibility of the user. Although care has been taken to ensure that our data is up to date and accurate, it is provided "as-is" and we give no warranty, express or implied, as to the accuracy, reliability, utility or completeness of this information. Users of this system assume all responsibility and risk for use of the data and website. Most of the NAS data have undergone substantial editing and review prior to posting, but not all errors or inaccuracies may have been detected. Consequently, NAS data should be regarded as provisional as subsequent reviews may result in significant revisions to the data. Data users are cautioned to consider carefully the provisional nature of the information before using it for decisions or inclusion in scientific or technical publications and reports. Information concerning the accuracy and appropriate uses of these

data may be obtained from the U.S Geological Survey (USGS). Please contact USGS to obtain information regarding original data sources.

This disclaimer applies both to individual use of the data and aggregate use of the data. It is strongly recommended that these data are directly acquired from a USGS source, and not indirectly through other sources which may have changed the data in some way. The USGS shall not be held liable for improper or incorrect use of the data retrieved from the NAS data retrieval Internet site.

We ask that any errors or problems found by the users be reported to us. USGS will make reasonable efforts to correct errors brought to its attention and may update or make changes to the documents provided by this server at any time without notice. However, USGS makes no commitment to update the information contained herein. Because the data in the central database is continually being updated, it is advisable to refresh data retrieved at least once a year after its receipt.

These data are the result of efforts by many of government and non-government participants in the field, as well as, USGS and various researchers and managers. All publications based on these data should acknowledge all of these efforts. If a publication is based solely on the analysis of NAS data, we suggest that you involve the NAS Program biologists with the writing and/or review of the manuscript. We would also appreciate receiving a reprint or copy of any publications or reports that make use of the NAS data." (http://nas.er.usgs.gov/disclaimer.aspx)

The U.S. Geological Survey provided further documentation about their Information Quality Guidelines at http://www.usgs.gov/info_qual/.

Environmental data layers included in the Map Explorer reside on University of Michigan Servers and are maintained by the University of Michigan.

Summary tables of the GLANSIS Risk Assessment Clearinghouse reside on NOAA servers and are maintained by GLANSIS in consultation with the Great Lakes Panel on ANS.

SECTION C: ASSESSMENT AND OVERSIGHT

C1. Assessments and Response Actions

The GLANSIS database, reports, fact sheets, and search capacities are spot-checked at regular intervals by GLANSIS staff. All materials are reviewed and revised until approved by the appropriate parties prior to posting (see Sections B5 and B9). Revisions are handled through the Program Manager.

When errors/deficiencies are noted or reported, steps to correct posted information are taken. If a recommended revision has the potential to be controversial, secondary opinions are sought from the appropriate expert scientists and a balanced case is presented.

C2. Reports to Management

Content for all reports will be prepared by the Program Manager and revised by the GLANSIS Executive Team prior to submission via the Program Manager to the NOAA GLRI Program Coordinator.

Quarterly project reports are compiled by the Program Manager and sent to the NOAA GLRI Program Coordinator for reporting to EPA.

Individual species assessments are released through NOAA technical reports and/or peer-reviewed publications.

GLANSIS regularly contributes to the State of the Great Lakes Indicator Reports for AIS.

SECTION D: DATA VALIDATION AND USABILITY

D1. Data Review, Validation, and Verification

The GLANSIS Program Manager and the Executive Committee are responsible for reviewing final project products prior to posting online (as detailed in Section B5). In summary, the GLANSIS Program Manager will review Research Associate work. Once preliminarily approved by the Program Manager, written material is passed on for review by the GLANSIS Executive Team and other the expert reviewers. Feedback from the GLANSIS Executive Team and expert reviewers is then incorporated until documentation meets their satisfaction, whereupon species profile information is entered online or published.

All information is provided with a full bibliographic citation and a copy of the source material is uploaded to the NAS bibliographic database, so that the user may come to his/her own conclusion about data suitability to meet particular needs. When conflicting source information arises, we present both sides of the issue. New records are flagged in NAS for review and are spot checked for accuracy by program staff at particular intervals (as specified in Section B5).

D2. Validation and Verification Methods

The NAS data entry system is hardwired to pull down menus and will not accept data entry that is incomplete or fails to follow minimum format requirements. GLANSIS staff review and/or spot check online entry of species fact sheet information, occurrence reports, and bibliographic information as detailed in Section B5 and summarized in Section D1. As every record is automatically coded with the username of the individual who entered the information, in the event of errors, this metadata helps to identify and review records for systematic patterns.

D3. Reconciliation with User Requirements

All GLANSIS data and products reside in the public domain https://www.glerl.noaa.gov/glansis/

Adaptive management, as supported by GLANSIS, relies on the ability to understand and forecast changes in an ecosystem. Focused on a system dominated by and inseparable from the effects of aquatic invaders, Great Lakes research cannot ignore these species. GLANSIS provides a central source of ecological and geographic data for modeling and forecasting the effects of invaders in this system (e.g., food web dynamics, nuisance and harmful algal blooms).

GLANSIS also supports regional invasive species management by fulfilling requests for nonnative species distributions (e.g., within Great Lakes National Parks, Lake Superior National Estuarine Research Reserve) or lists of species introduced along particular pathways (e.g., organisms in trade, in response to a U.S. legislative request), contributing to reports (e.g., State of the Lakes Ecosystem Conference

Reports, International Joint Commission, Great Lakes Panel on Aquatic Nuisance Species, Aquatic Nuisance Species Task Force) and risk assessments (e.g., the Great Lakes Mississippi River Interbasin Study), and interfacing with EPA's Watershed Wiki.